

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division

Washington, D.C. 20594

August 10, 2017

Flight Data Recorder

Specialist's Factual Report

By Greg Smith

1. EVENT SUMMARY

Location: Fort Lauderdale, Florida
Date: October 28, 2016
Aircraft: McDonnell Douglas MD-10-10F
Registration: N370FE
Operator: FedEx Express
NTSB Number: DCA17MA022

On October 28, 2016, about 1751 eastern daylight time, FedEx Express flight 910, a McDonnell Douglas MD-10-10F, N370FE, experienced a left main landing gear collapse after landing on runway 10L at Fort Lauderdale–Hollywood International Airport (FLL), Fort Lauderdale, Florida. The airplane came to rest off the left side of the runway and subsequently caught fire. The two flight crew members were not injured and the airplane was substantially damaged. The cargo flight was operating under 14 *Code of Federal Regulations* (CFR) Part 121 and had originated from Memphis International Airport (MEM), Memphis, Tennessee.

2. FLIGHT DATA RECORDER GROUP

A flight data recorder (FDR) group was not convened.

3. FDR Carriage Requirements

The event aircraft, N370FE, was manufactured in February 1972, and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 22 parameters, as cited in 14 CFR Part 121.344.

4. DETAILS OF FDR INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following FDRs:

Recorder Manufacturer/Model: **Honeywell SSFDR 980-4700-042, 256 wps**
Recorder Serial Number: **10591**

Recorder Manufacturer/Model: **FDR File from GE CVFDR 175497-01-01, 256 wps¹**
Recorder Serial Number: **0000061**

¹ The primary function of this device is as the aircraft's cockpit voice recorder (CVR), it provides a redundant FDR function for the aircraft.

Recorder Manufacturer/Model: **PCMCIA Card Z-31-096-01, Rev B, 256 wps**
Recorder Serial Number: **1198**

4.1. Honeywell SSFDR Description

The Honeywell solid state flight data recorder (SSFDR) records airplane flight information in a digital format using solid-state flash memory as the recording medium. The SSFDR can receive data in the ARINC 573/717/747 configurations and can record a minimum of 25 hours of flight data. It is configured to record 256 12-bit words of digital information every second. Each grouping of 256 words (each second) is called a subframe. Each subframe has a unique 12-bit synchronization (sync) word identifying it as subframe 1, 2, 3, or 4. The sync word is the first word in each subframe. The data stream is "in sync" when successive sync words appear at proper 256-word intervals. Each data parameter (for example, altitude, heading, and airspeed) has a specifically assigned word number within the subframe. The SSFDR is designed to meet the crash-survivability requirements of TSO-C124.

4.1.1. Recorder Condition

The recorder was in good condition and the data were extracted normally from the recorder.

4.1.2. Recording Description

The SSFDR recording contained approximately 27.2 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The event flight was the last flight of the recording and its duration was approximately 2 hours. All data presented in this report is from the SSFDR.

4.2. GE CVFDR Description

The GE cockpit voice flight data recorder (CVFDR) is a multi-function device that records airplane audio and flight data information in a digital format using solid-state flash memory as the recording medium. The CVFDR can receive data in the ARINC 573/717/747 configurations and can record a minimum of 25 hours of flight data. It is configured to record the same data stream provided to the Honeywell SSFDR thus providing a redundant FDR for the aircraft. The CVFDR is designed to meet the crash-survivability requirements of TSO-C124.

4.2.1. Recorder Condition

See the CVR Group Chairman's factual report.

4.2.2. Recording Description

The CVFDR FDR data file was evaluated and found to be a duplicate set of the SSFDR data. No further review of the CVFDR FDR data file was conducted.

4.3. PCMCIA Card Description

The PCMCIA Card is a storage and transfer medium for Flight Operations Quality Assurance (FOQA) program data. It is configured to record the same data provided to the Honeywell SSFDR thus providing a redundant FDR for the aircraft which may contain more than the

required 25 hours of flight data. It primarily functions as quick access media for transferring data from completed flights to ground processing stations.

4.3.1. Recorder Condition

The PCMCIA Card was in good condition and the files were downloaded using normal procedures.

4.3.2. Recording Description

The PCMCIA Card did not contain any data from the accident flight. The last flight recorded was the 4th flight prior to the accident flight. This is not unusual because the card is a transfer media. The data from the missing flights may not have been transferred from other onboard storage to the card yet. No further review of the PCMCIA card data was conducted because the SSFDR captured all the accident flight data and there was no need to review historic flight data.

4.4. Engineering Units Conversions

The engineering units conversions used for the data contained in this report are based on documentation from the operator and aircraft manufacturer. Where applicable, the conversions have been changed to ensure that the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+).²

Table A-1 lists the FDR parameters verified and provided in this report. Specifically, table A-1 lists the parameter names, plot/table labels, and units. Additionally, table A-2 describes the unit and discrete abbreviations used in this report.

4.5. Time Correlation

Correlation of the FDR data from SRN to the event local time, Eastern Daylight Time (EDT), was established by using the recorded Time GMT³ hours, Time GMT Minutes, and Time GMT Seconds and then applying an additional four hours offset to change GMT to EDT.

Accordingly, the time offset for the event flight data from SRN to local EDT is the following: EDT = SRN – 33726.76171875. Therefore, for the rest of this report, all times are referenced as EDT, not SRN.

4.6. FDR Plots and Corresponding Tabular Data

Figures 1 to 15 contain FDR data recorded during the October 28, 2016, event. Table A-1 list the parameters evaluated and included in this report and indicates in which figure(s) each parameter is plotted.

Figures 1, 3, 5, 7, 9, 11, and 13 plot the parameters over a 10-minute time range, labeled as 5000' to End of Recording, beginning at 17:41:40 EDT. This time range includes the

² CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

³ GMT is Greenwich Mean Time which is also known as Coordinated Universal Time (UTC).

aircraft leveling off at about 5000 feet pressure altitude and continues through the end of the recording.

Figures 2, 4, 6, 8, 10, 12, and 14 plot the parameters over a 100-second time range, labeled as Touchdown, beginning at 17:49:45 EDT, about 46 seconds prior to touchdown.

Figure 15 is a summary plot showing 25 seconds of data from parameters related to indicating the aircraft behavior as it touched down and the gear collapsed. This figure is annotated with the following key events.

Time⁴	Event
17:50:31.00	Spikes in vertical and longitudinal accelerations indicating the approximate time of the initial touchdown. [Approximate Touchdown] ⁵
17:50:41.25	Increase in brake pedal position angle and decrease in longitudinal acceleration indicate braking. [Brakes Applied]
17:50:43.00	Left roll angle increases indicating that the gear has collapsed. [Gear can no longer support the aircraft (start of roll)]
17:50:44.00	Roll angle stabilizing at about -12 degrees (left wing down) and large vertical acceleration spike indicate that the left wing and/or engine have contacted the ground. [Left wing/engine hits the ground (roll stabilizes + big G spike)]

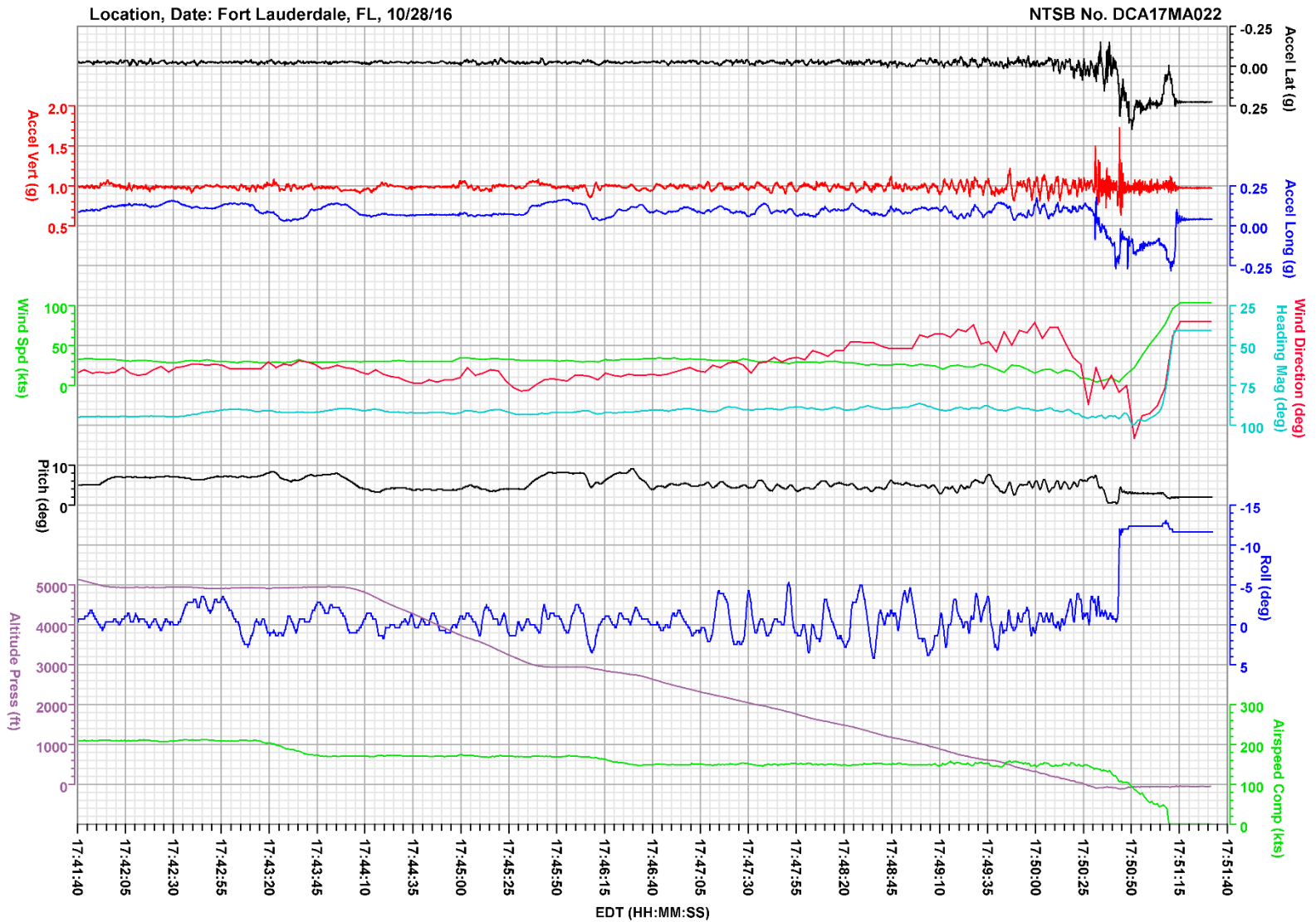
Figures 1 through 15 are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

The tabular data for all parameters listed in table A-1 from the start of the flight through the end of the recording are provided in electronic compressed (zipped) comma separated value (*.csv) format as attachment 1 to this report.

⁴ Approximate EDT to the nearest ¼ second.

⁵ Bracketed text is the plot annotation.

Figure 1. Plot of basic parameters during approach.
Basic Parameters - 5000' to End of Recording



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Figure 2. Plot of basic parameters during touchdown.

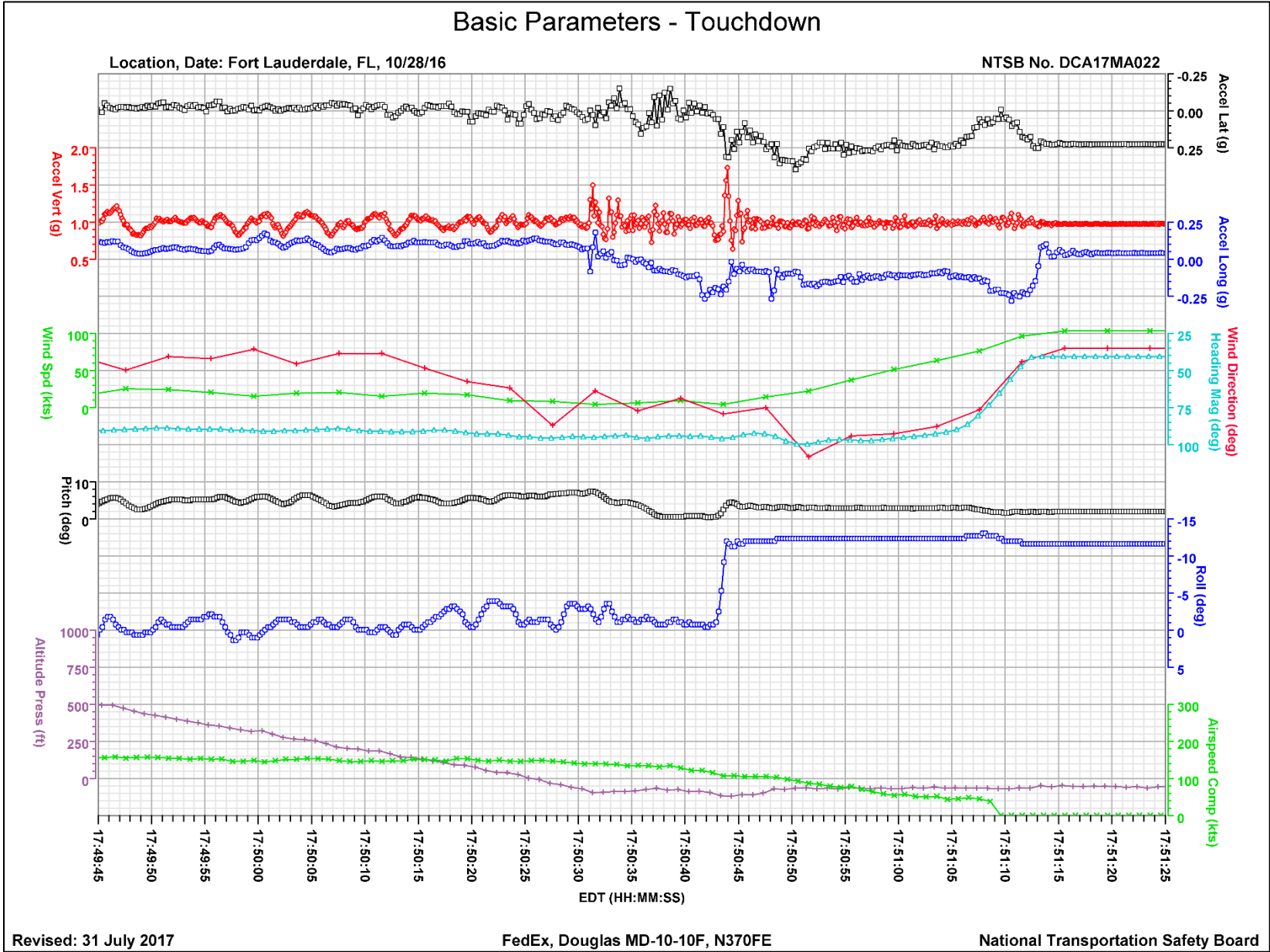


Figure 3. Plot of brakes, thrust reverser, spoiler and landing gear parameters during approach.

Brake, Reverser, Spoiler & Gear Parameters - 5000' to End of Recording

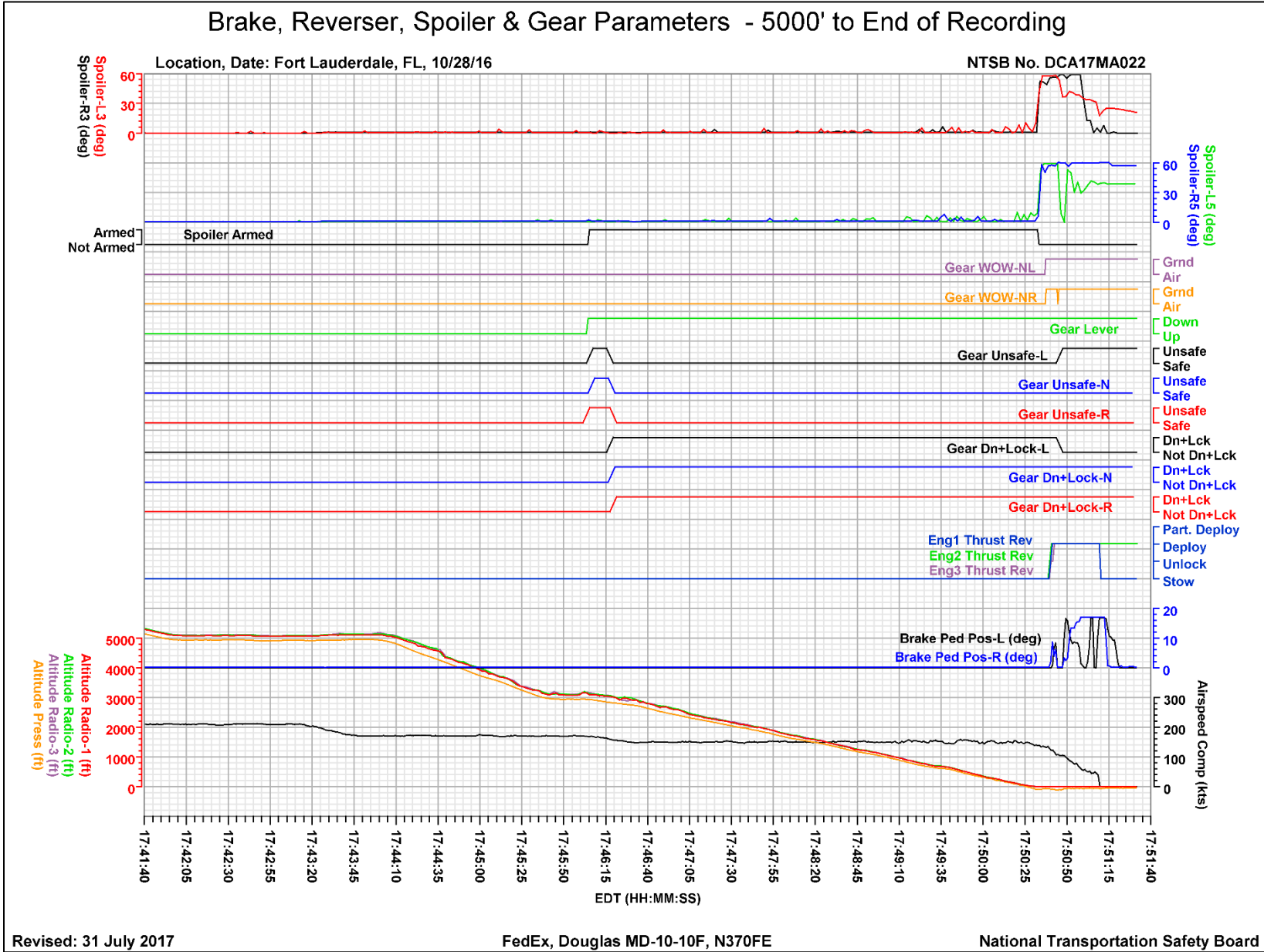


Figure 4. Plot of brakes, thrust reverser, spoiler and landing gear parameters during touchdown.

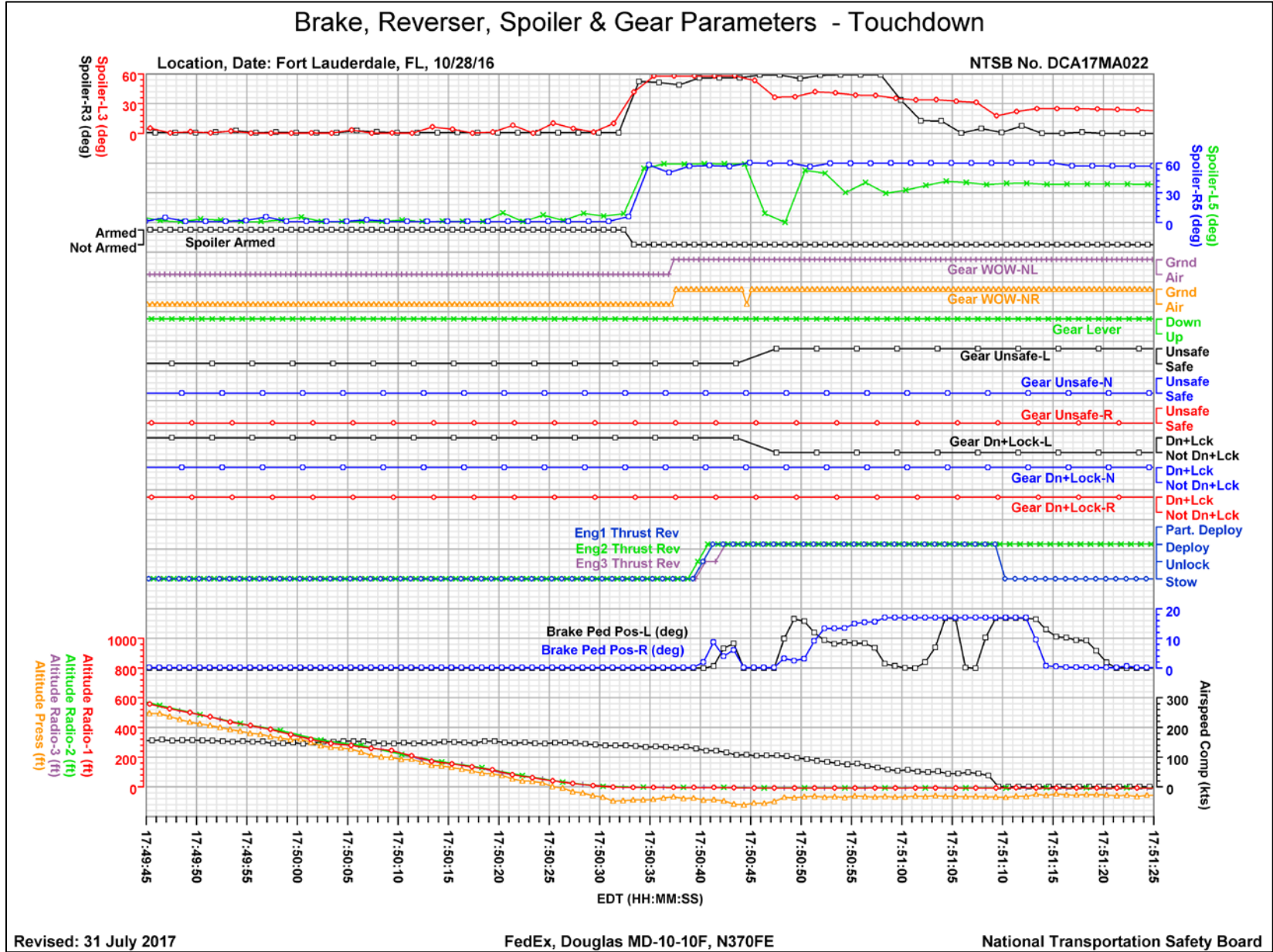
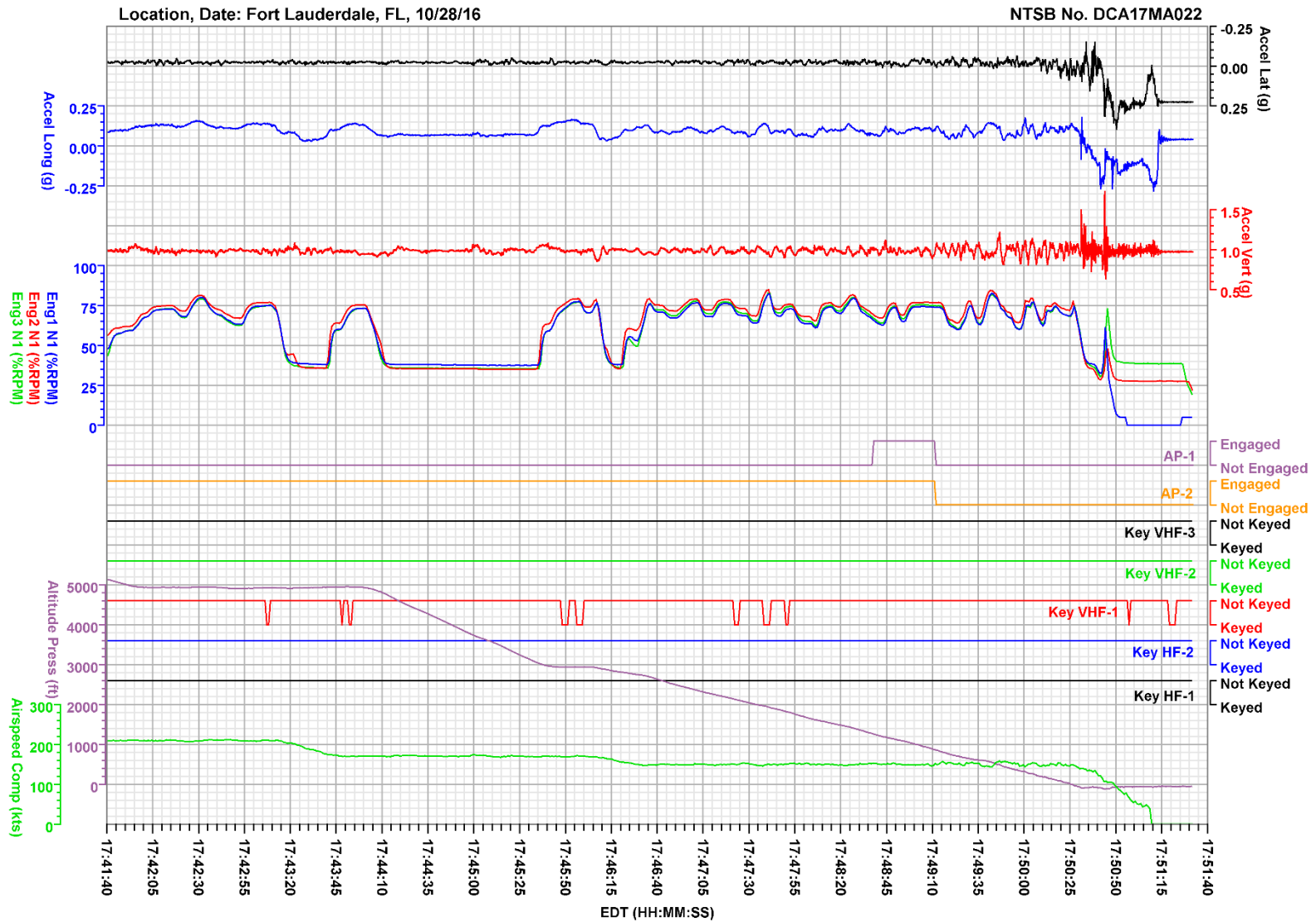


Figure 5. Plot of engine, auto-pilot engagement and radio keying parameters during approach.

Engine, Auto-Pilot & Radio Parameters - 5000' to End of Recording



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Figure 6. Plot of engine, auto-pilot engagement and radio keying parameters during touchdown.

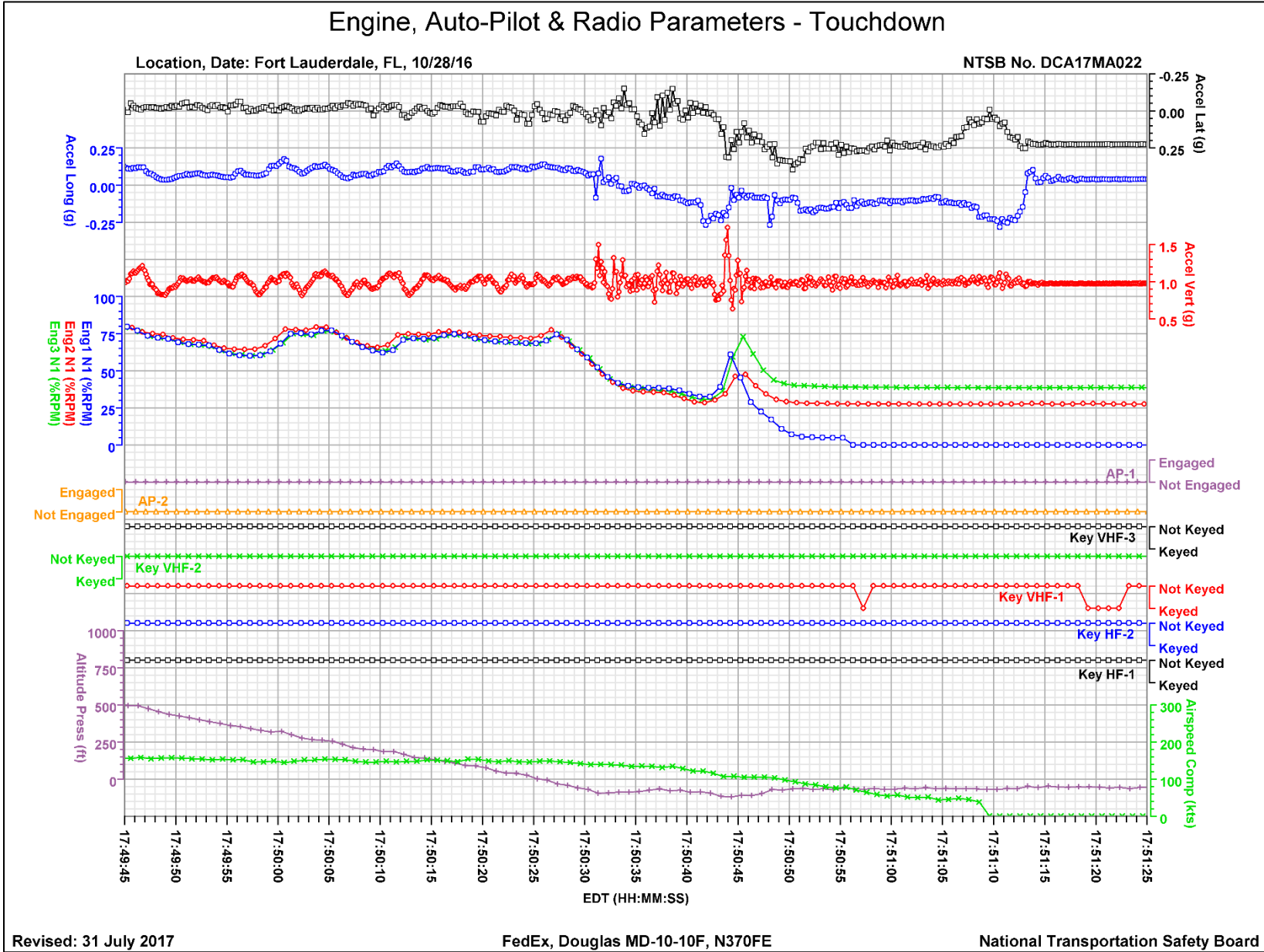
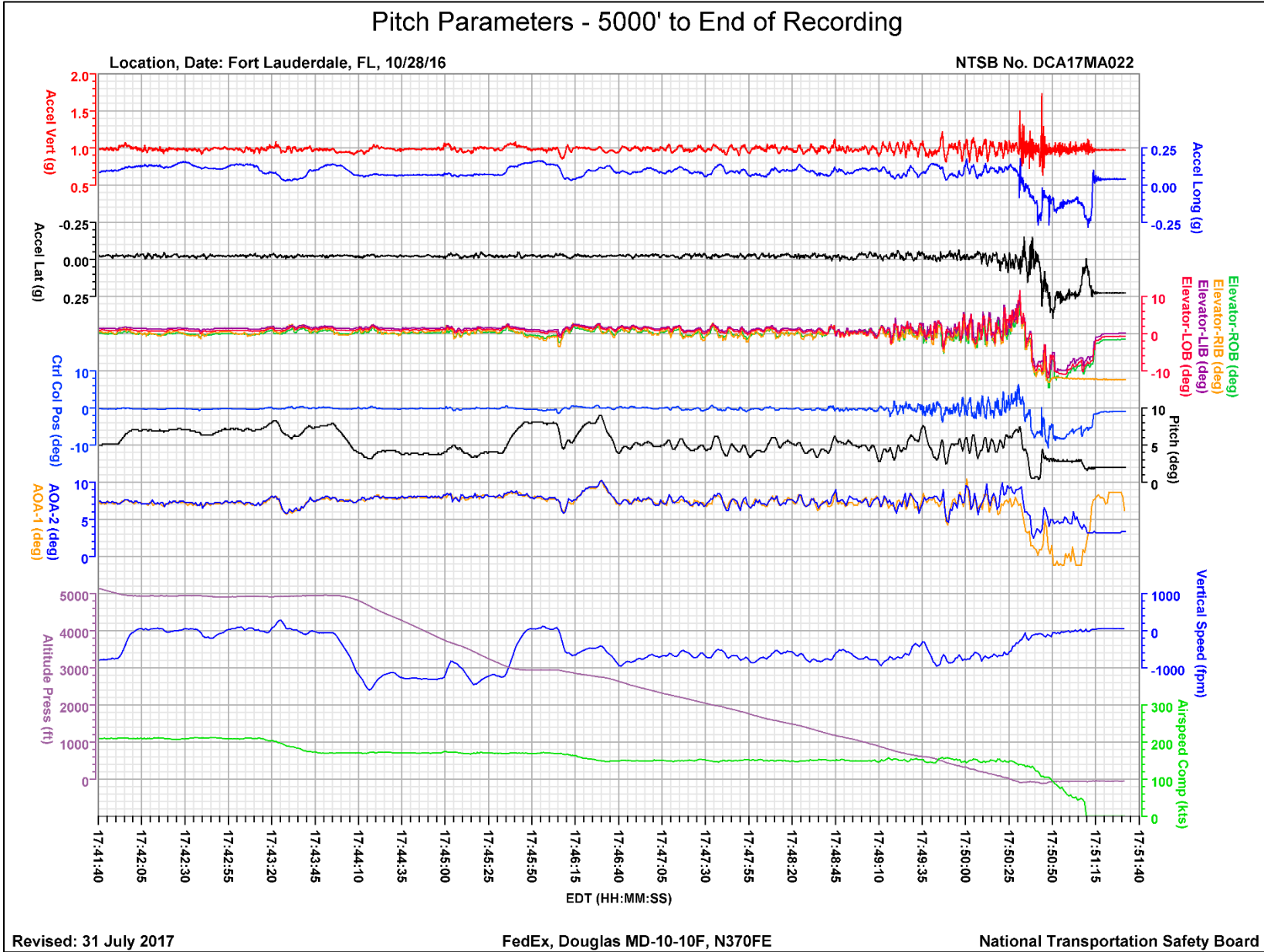


Figure 7. Plot of pitch related parameters during approach.
Pitch Parameters - 5000' to End of Recording



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Figure 8. Plot of pitch related parameters during touchdown.

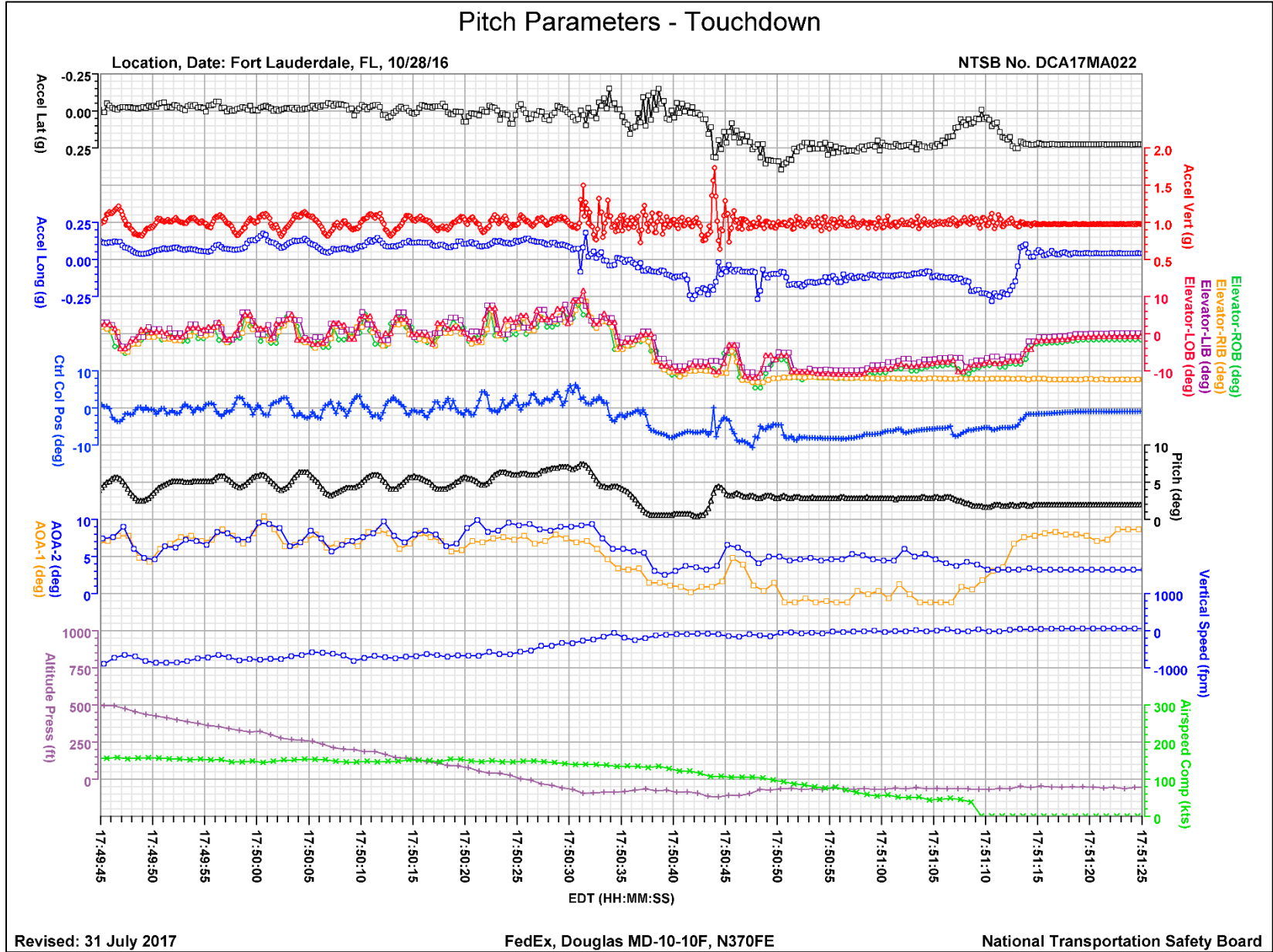
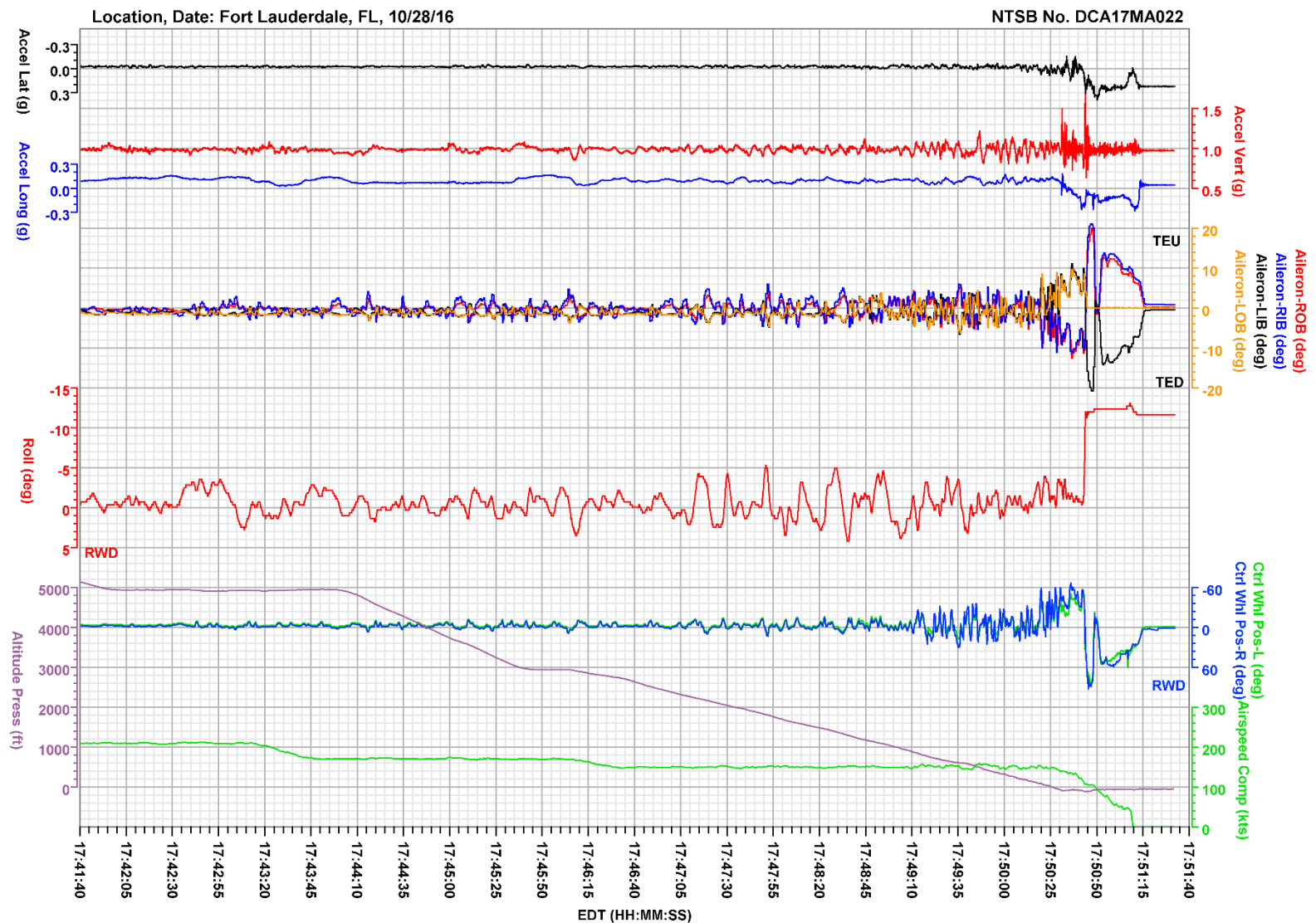


Figure 9. Plot of roll related parameters during approach.

Roll Parameters - 5000' to End of Recording



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Figure 10. Plot of roll related parameters during touchdown.

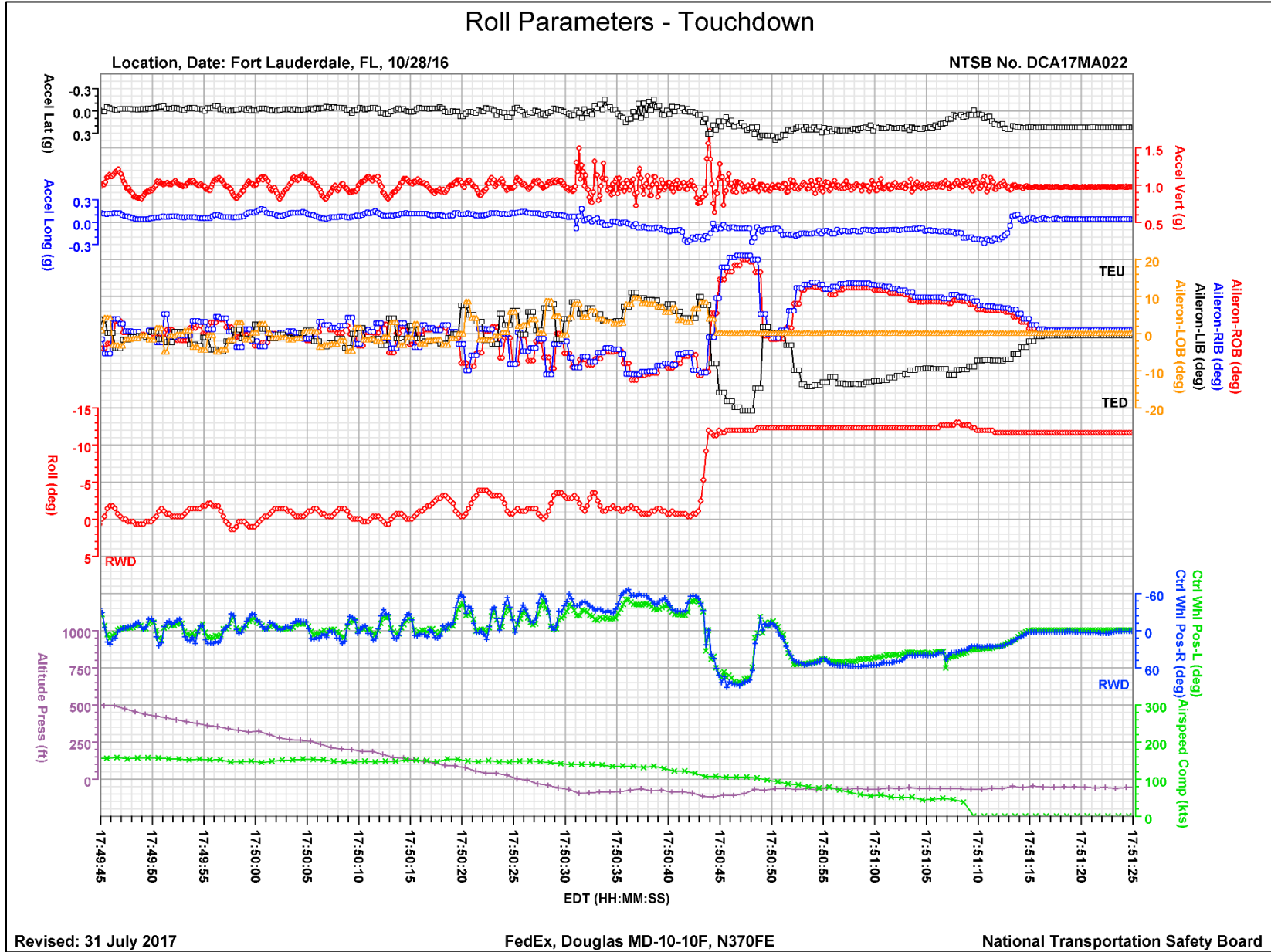
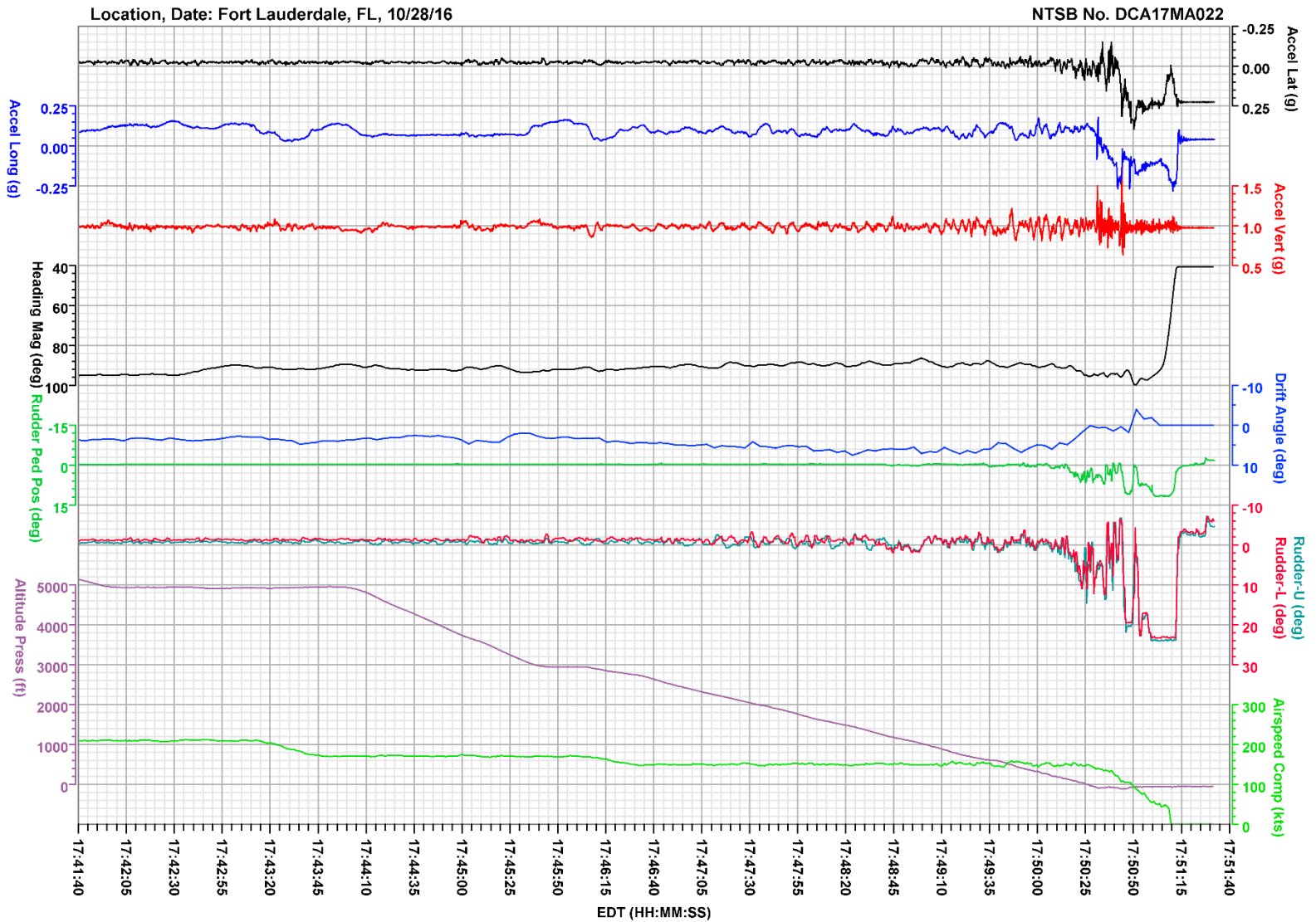


Figure 11. Plot of yaw related parameters during approach.

Yaw Parameters - 5000' to End of Recording



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Figure 12. Plot of yaw related parameters during touchdown.

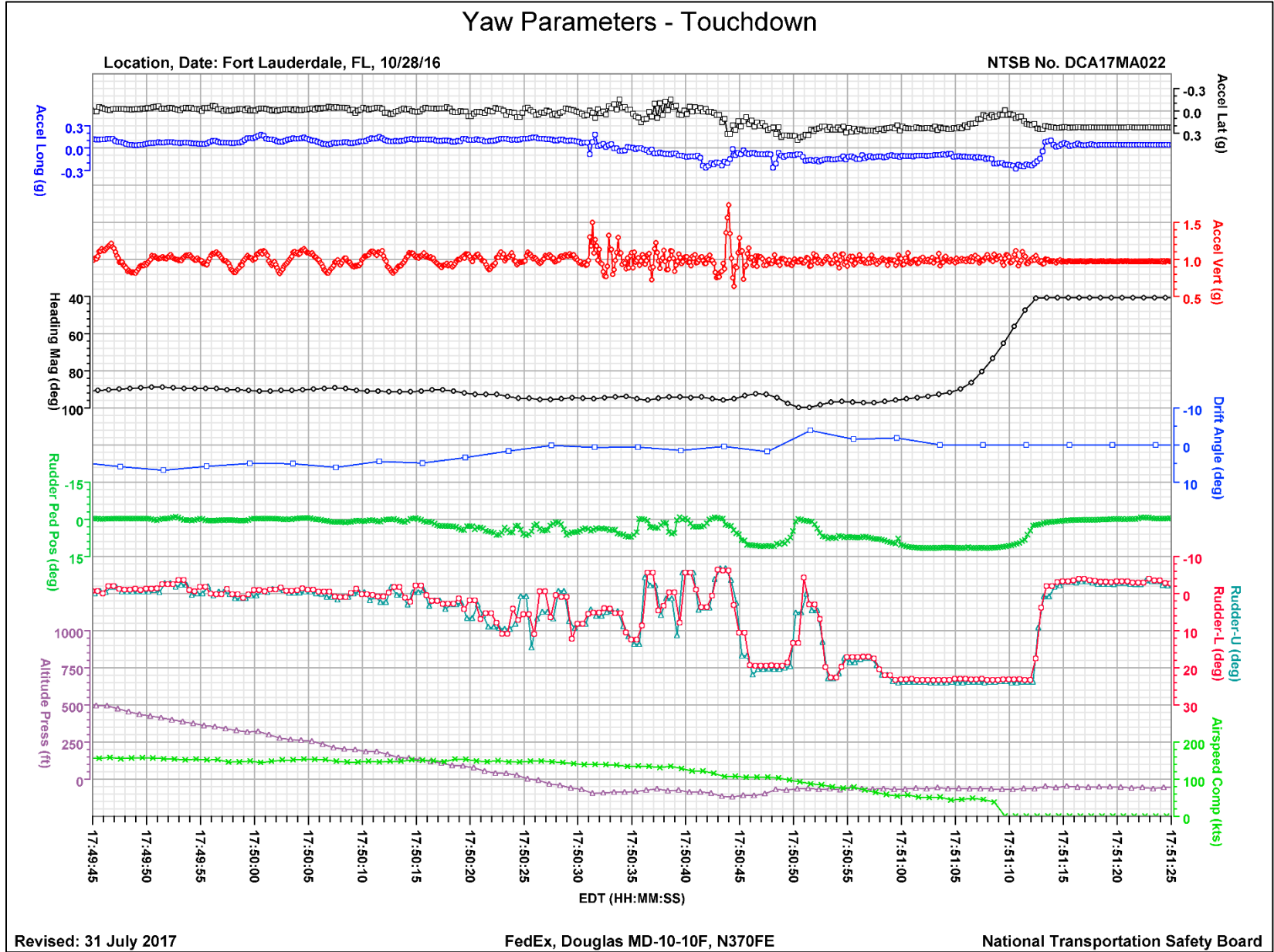


Figure 13. Plot of flap and slat parameters during approach.
Flap / Slat Parameters - 5000' to End of Recording

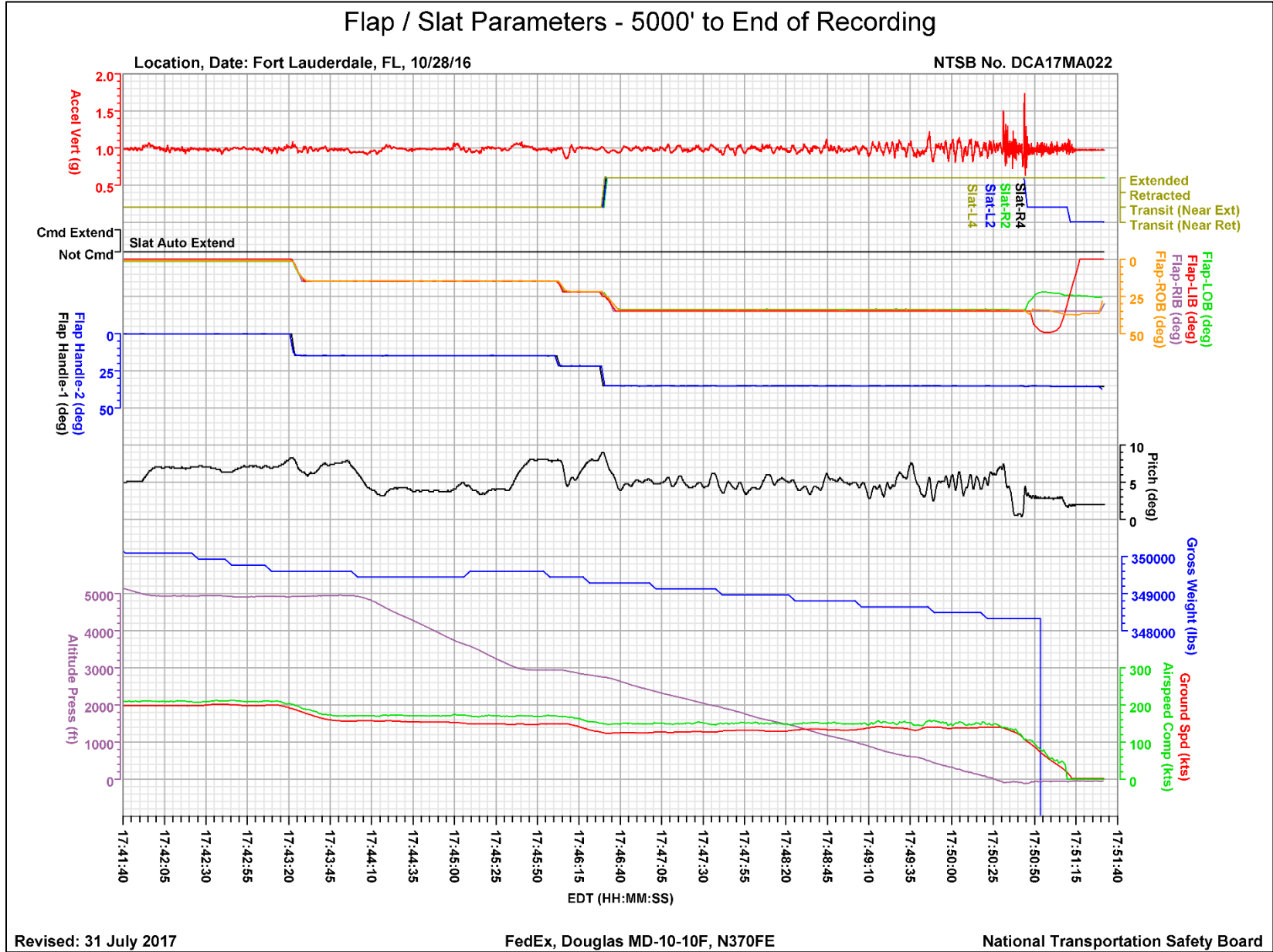


Figure 14. Plot of flap and slat parameters during touchdown.

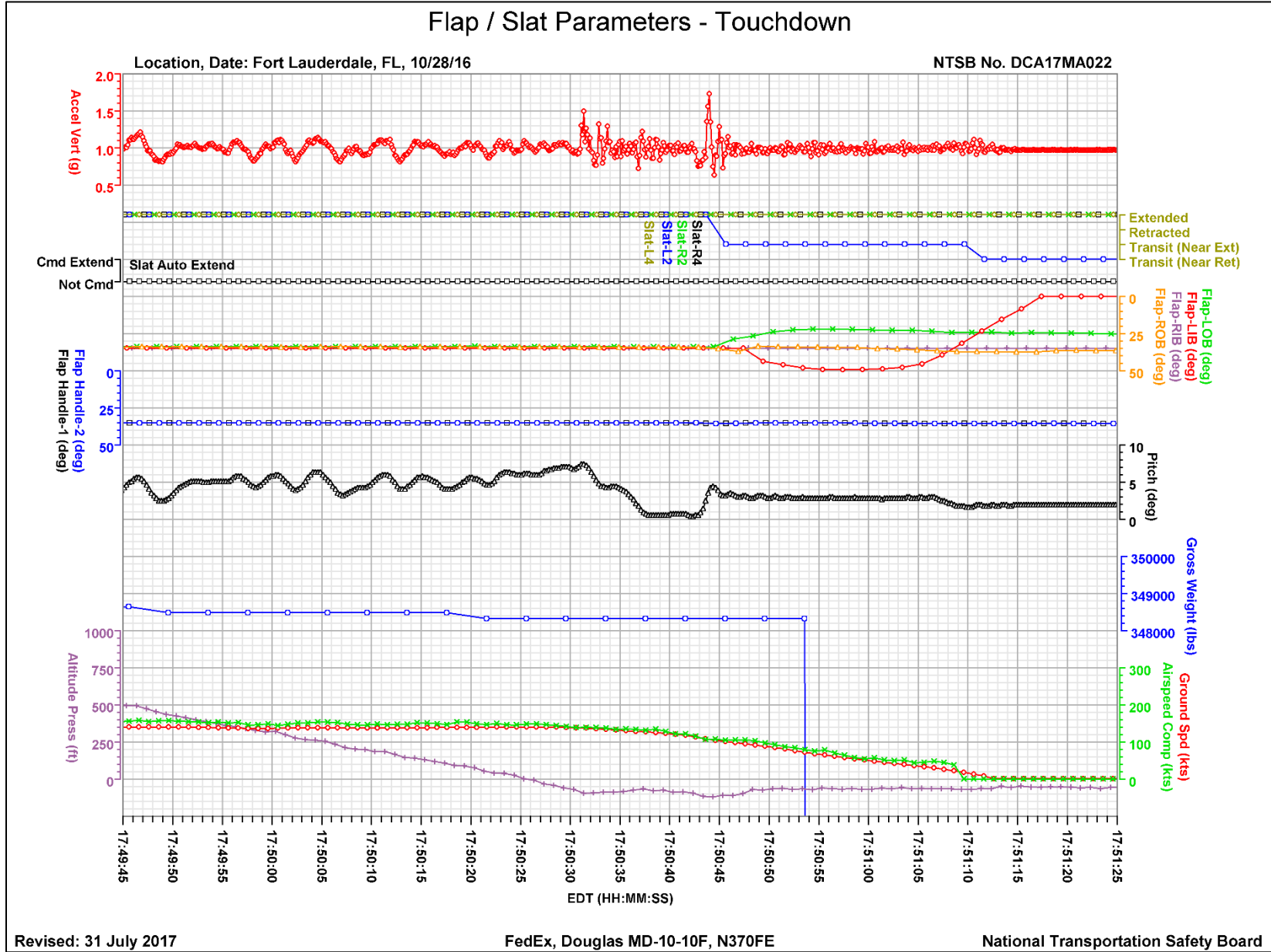
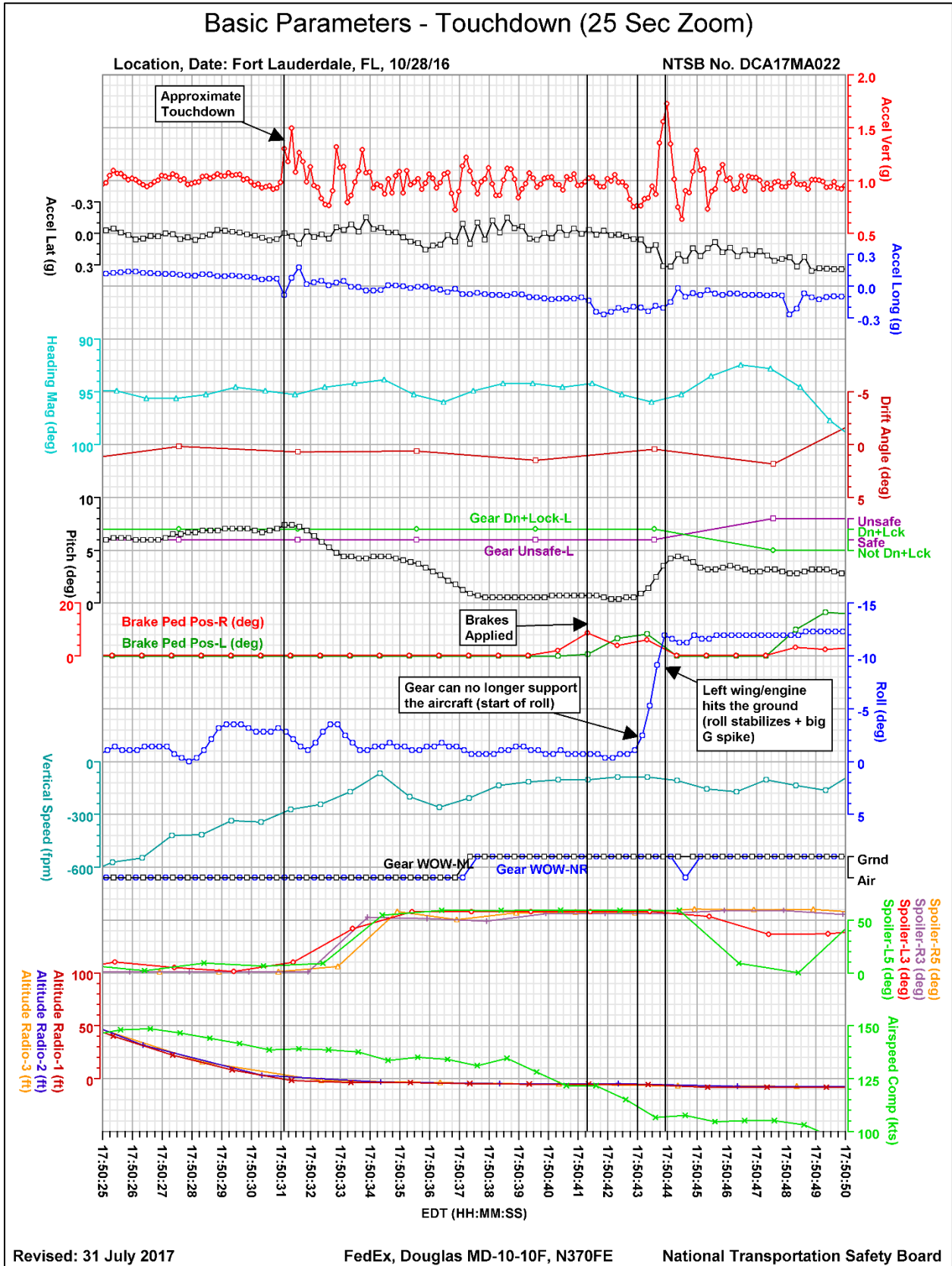


Figure 15. Annotated plot of parameters indicating touchdown and gear collapse.



APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameter names, plot/table labels, and units. Additionally, table A-2 describes the unit and discrete abbreviations used in this report.

Table A-1. Verified and provided FDR parameters.

Parameter Name	Plot / Table Label	Units	Figure(s)
Lateral Acceleration	Accel Lat	g	1, 2, 5-12, 15
Longitudinal Acceleration	Accel Long	g	1, 2, 5-12, 15
Vertical Acceleration	Accel Vert	g	1, 2, 5-15
Left Inboard Aileron Position	Aileron-LIB	deg	9, 10
Left Outboard Aileron Position	Aileron-LOB	deg	9, 10
Right Inboard Aileron Position	Aileron-RIB	deg	9, 10
Right Outboard Aileron Position	Aileron-ROB	deg	9, 10
Computed Airspeed	Airspeed Comp	kts	1-15
Pressure Altitude	Altitude Press	ft	1-14
Radio Altitude 1	Altitude Radio-1	ft	3, 4, 15
Radio Altitude 2	Altitude Radio-2	ft	3, 4, 15
Radio Altitude 3	Altitude Radio-3	ft	3, 4, 15
Angle of Attack -1	AOA-1	deg	7, 8
Angle of Attack - 2	AOA-2	deg	7, 8
Autopilot 1 Engaged	AP-1		5, 6
Autopilot 2 Engaged	AP-2		5, 6
Left Brake Pedal Position	Brake Ped Pos-L	deg	3, 4, 15
Right Brake Pedal Position	Brake Ped Pos-R	deg	3, 4, 15
Control Column Position	Ctrl Col Pos	deg	7, 8
Left Control Wheel Position	Ctrl Whl Pos-L	deg	9, 10
Right Control Wheel Position	Ctrl Whl Pos-R	deg	9, 10
Drift Angle	Drift Angle	deg	11, 12, 15
Left Inboard Elevator Position	Elevator-LIB	deg	7, 8
Left Outboard Elevator Position	Elevator-LOB	deg	7, 8
Right Inboard Elevator Position	Elevator-RIB	deg	7, 8
Right Outboard Elevator Position	Elevator-ROB	deg	7, 8
Engine 1 N1	Eng1 N1	%RPM	5, 6
Engine 1 Thrust Reverser Position	Eng1 Thrust Rev		3, 4
Engine 2 N1	Eng2 N1	%RPM	5, 6
Engine 2 Thrust Reverser Position	Eng2 Thrust Rev		3, 4
Engine 3 N1	Eng3 N1	%RPM	5, 6
Engine 3 Thrust Reverser Position	Eng3 Thrust Rev		3, 4
Flaps Disagree	Flap Disagree		
Flap Handle Position 1	Flap Handle-1	deg	13, 14
Flap Handle Position 2	Flap Handle-2	deg	13, 14
Left Inboard Flap Position	Flap-LIB	deg	13, 14
Left Outboard Flap Position	Flap-LOB	deg	13, 14
Right Inboard Flap Position	Flap-RIB	deg	13, 14
Right Outboard Flap Position	Flap-ROB	deg	13, 14
Left Main Landing Gear Down and Locked	Gear Dn+Lock-L		3, 4, 15
Nose Landing Gear Down and Locked	Gear Dn+Lock-N		3, 4
Right Main Landing Gear Down and Locked	Gear Dn+Lock-R		3, 4
Landing Gear Lever Position	Gear Lever		3, 4
Left Main Landing Gear Unsafe	Gear Unsafe-L		3, 4, 15
Nose Landing Gear Unsafe	Gear Unsafe-N		3, 4
Right Main Landing Gear Unsafe	Gear Unsafe-R		3, 4

Parameter Name	Plot / Table Label	Units	Figure(s)
Nose Gear Compressed-L	Gear WOW-NL		3, 4, 15
Nose Gear Compressed-R	Gear WOW-NR		3, 4, 15
Gross Weight	Gross Weight	lbs	13, 14
Ground Speed	Ground Spd	kts	13, 14
Magnetic Heading	Heading Mag	deg	1, 2, 11, 12, 15
HF Radio 1 Keyed	Key HF-1		5, 6
HF Radio 2 Keyed	Key HF-2		5, 6
VHF Radio 1 Keyed	Key VHF-1		5, 6
VHF Radio 2 Keyed	Key VHF-2		5, 6
VHF Radio 3 Keyed	Key VHF-3		5, 6
Present Position Latitude	Latitude	deg	
Present Position Longitude	Longitude	deg	
Mach Number	Mach		
Pitch Attitude	Pitch	deg	1, 2, 7, 8, 13-15
Roll Attitude	Roll	deg	1, 2, 9, 10, 15
Lower Rudder Position	Rudder-L	deg	11, 12
Rudder Pedal Position	Rudder Ped Pos	deg	11, 12
Upper Rudder Position	Rudder-U	deg	11, 12
Auto Slat Extend	Slat Auto Extend		13, 14
Slat L2 Position	Slat-L2		13, 14
Slat L4 Position	Slat-L4		13, 14
Slat R2 Position	Slat-R2		13, 14
Slat R4 Position	Slat-R4		13, 14
Slats Disagree	Slats Disagree		
Spoilers Armed	Spoiler Armed		3, 4
L3 Spoiler Position	Spoiler-L3	deg	3, 4, 15
L5 Spoiler Position	Spoiler-L5	deg	3, 4, 15
R3 Spoiler Position	Spoiler-R3	deg	3, 4, 15
R5 Spoiler Position	Spoiler-R5	deg	3, 4, 15
Stabilizer Position 1	Stabilizer-1	deg	
Stabilizer Position 2	Stabilizer-2	deg	
Stick Shaker 1	Stick Shaker-1		
Stick Shaker 2	Stick Shaker-2		
Total Air Temperature	TAT	degC	
Day	Time GPS Day	day	
GPS Time-Hrs	Time GPS Hrs	hrs	
GPS Time-Min	Time GPS Min	min	
Month	Time GPS Month	month	
GPS Time-Sec	Time GPS Sec	sec	
Year	Time GPS Year	year	
Vertical Speed	Vertical Speed	fpm	7, 8, 15
Master Warning	Warn Master		
Master Caution	Warn Master Caution		
Wind Direction	Wind Direction	deg	1, 2
Wind Speed	Wind Spd	kts	1, 2

NOTE: This FDR records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The pressure altitude information presented in the FDR plots and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

NOTE: Parameters with a blank unit description in table A-1 are discrettes. A discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.

Table A-2. Unit and Discrete abbreviations.

Unit and Discrete Abbreviations	Descriptions
%RPM	percent revolutions per minute
Cmd	Command(ed)
deg	degrees
degC	degrees Celsius
Dn+Lck	Down and Locked
Ext	Extended
fpm	feet per minute
ft	feet
g	g
Grnd	Ground
hrs	hours
kts	knots
lbs	pounds
min	minutes
Part.	Partially
Ret	Retracted
RWD	Right Wing Down
sec	seconds
TEU	Trailing Edge Up
TED	Trailing Edge Down
wps	words per second